Key

Extra Final Exam Practice Problems Chapters 1-9

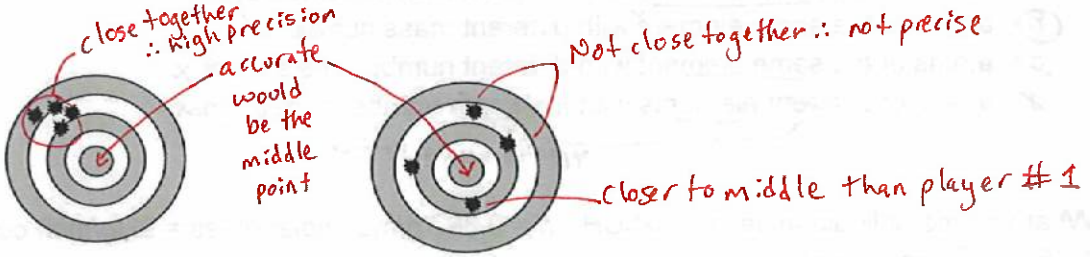
For complete credit, please show all work. Always use appropriate significant figures!

The Periodic Table of the Elements

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

1. Consider the following diagrams, which statement best describes them?


close together ∴ high precision
accurate would be the middle point
Not close together ∴ not precise
closer to middle than player #1

Player #1 Player #2

a. Player #1 is ~~accurate~~ and precise.
b. Player #1 is ~~accurate~~ and Player #2 is precise.
c. Player #1 is precise and Player #2 is accurate (at least more than #1!)
d. Player #2 is ~~precise~~ but not accurate.

CHM113 General Chemistry I (Dr. Jen) Key

2. All of the following are characteristic properties of phosphorus. Which one is a chemical property?

   a. Red phosphorus and white phosphorus are solid allotropic forms. (phase/state of matter = physical property)
   b. The red form melts at about 600°C, and the white form melts at 44°C. (physical property: m.p.)
   c. The white form is soluble in liquid carbon disulfide but is insoluble in water. (solubility)
   d. When exposed to air, white phosphorus will burn spontaneously, but red phosphorus will not. (combustion = rxn = chemical property)
   e. The red form of phosphorus is insoluble in both water and carbon disulfide. (solubility = physical property)

3. A flask has a mass of 98.265 g when empty and 107.15 g when filled with 3.987 liters of an unknown gas. Determine, to the correct number of significant figures, the density of the gas.

   a. 2.228 g/L b. 2.23 g/L c. 2.2285 g/L d. 0.449 g/L e. 0.4487 g/L

$$d = \frac{\text{mass}}{\text{volume}} = \frac{107.15\text{g} - 98.265\text{g}}{3.987\text{ L}} = \frac{8.885\text{g}}{3.987\text{L}} = \frac{8.89\text{g}}{3.987\text{ L}} = 2.229\text{ g/L} = 2.23\text{ g/L}$$

(3 s.f.; 4 s.f.; 3 s.f.)

4. A series of silicon–hydrogen compounds with the general formula Si_nH_{2n+2} can be represented by the known compounds SiH_4, Si_2H_6, and Si_3H_8. This best illustrates the law of

   a. Conservation of mass. – they will weigh different amounts
   b. Conservation of charge. – they are all neutral molecules with covalent bonds
   c. Conservations of atoms. – there are a different number of atoms in each
   d. Constant Composition.
   e. Multiple Proportions. – the proportion is the same in each

5. Isotopes are (different # neutrons so dif. mass #)

   a. ~~atoms of the same element with different atomic numbers~~ (dif. # protons) ×
   b. atoms of the same element with different mass numbers ✓
   c. ~~atoms of the same element with different number of electrons~~ ×
   d. ~~atoms of different elements with the same number of neutrons~~ ×

   (opposite would be true)

6. What volume of liquid toluene ($C_6H_5CH_3$, d = 0.867 g/mL, molar mass = 92g/mol) contains 1.95×10^{24} molecules?

   a. 0.0305 L b. 0.259 L c. 0.344 L d. 2.91 L e. 24.7 L

$$1.95\times10^{24} \times \frac{1\text{ mol}}{6.022\times10^{23}} \times \frac{92\text{g}}{\text{mol}} \times \frac{\text{mL}}{0.867\text{g}} \times \frac{1\text{ L}}{1000\text{mL}} = 0.3436\text{ L} = 0.344\text{ L}$$

7. What is the percentage by mass of chlorine in DDT, $C_{14}H_9Cl_5$? $M_{Cl} = 35.4527\text{ g/mol}$

   a. 26.2% b. 32.4% c. 63.0% d. 50.0% e. 66.0%

$$M_{DDT} = (14\times12.0107\text{g/mol}) + (9\times1.00794\text{g/mol}) + (5\times35.4527\text{g/mol}) = 354.4848\text{ g/mol}$$

$$\text{mass \%} = \frac{(\#)(M)}{\text{total } M}\times100 = \frac{5\times35.4527\text{g/mol}}{354.4848\text{g/mol}}\times100 = 50.0\%$$

Key

amu = g/mol

8. It is found that 0.215 g of element X contains 1.20×10^{21} atoms. The atomic mass of X is:

a. 54.0 amu b. 71.5 amu c. 88.6 amu (d) 108 amu e. 124 amu

$1.20\times10^{21}\text{ atoms} \times \frac{1\text{ mol atoms}}{6.022\times10^{23}\text{ atoms}} = 0.00200\text{ moles}$

$M = \frac{0.215\text{g}}{0.00200\text{ mol}} = 107.5\text{ g/mol} = 108\text{ amu}$

$2x + -2(3) = 0$

$x = +3$

9. The formula for europium oxide is Eu_2O_3. On the basis of this information, the formula for the chlorate of europium would be expected to be

a. $EuCl_2$ b. $EuCl_3$ c. $Eu_2(ClO_3)_3$ d. $Eu(ClO_4)_2$ (e) $Eu(ClO_3)_3$

chloride

perchlorate

$Eu(ClO_3)_3$

10. Which of the following are NOT strong electrolytes?

↳ weak or non-electrolyte

a. $NaNO_3$ (b) $PbCl_2$ c. $MgSO_4$ d. HCl

soluble salt = strong electrolyte

insoluble salt = non-electrolyte

soluble salt = strong electrolyte

strong acid = strong electrolyte

11. Which solution has the highest concentration of chloride ions?

a. 1.25 M $AlCl_3$ b. 3.0 M HCl (c) 2.0 M $CaCl_2$ d. 1.0 M $MgCl_2$

x 3 = 3.75 M

x 1 = 3.0 M

x 2 = 4.0 M

x 2 = 2.0 M

12. When engine loses 47 kJ of heat as it provides 25 kJ of energy to turn an axle. What is the change in internal energy?

q = heat lost, w = does work

$\Delta E = q + w = (-47\text{ kJ}) + (-25\text{ kJ})$

$\Delta E = -72\text{ kJ}$

a. 22 kJ b. -22 kJ c. 0 kJ, it's a state function d. 72 kJ (e) -72 kJ

13. If you hated sleeping in a cold, cold bed (around 5 °C) – you could warm your bed by heating either 15 kg of water to 95 °C, 15 kg of aluminum to 95 °C, or 15 kg of gold to 95 °C – which would you select?

$q = mC_s\Delta T$

m same, ΔT same

highest C_s will give most heat

(a) Water (c = 4.184 J/g·K) b. aluminum (c = .900 J/g·K) c. gold (c = .129 J/g·K)

d. It doesn't matter – they are all heated to the same temperature.

14. In order to dilute 40.0 mL of 0.600 M HCl to 0.100 M, the volume of water that would need to be added would be

V_c M_c M_d $V_{added} = V_d - V_c$ $M_cV_c = M_dV_d$

a. 80.0 mL b. 100. mL c. 160. mL (d) 200. mL e. 240. mL

$V_d = \frac{M_cV_c}{M_d} = \frac{(0.600\text{M})(40.0\text{mL})}{0.100\text{M}}$

$V_d = 240.\text{ mL}$ once diluted

$V_{added} = 240.\text{ mL} - 40.0\text{ mL} = 200.\text{ mL}$

15. When solutions of barium chloride and sodium sulfate are mixed, the spectator ions in the resulting reaction are:

$BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

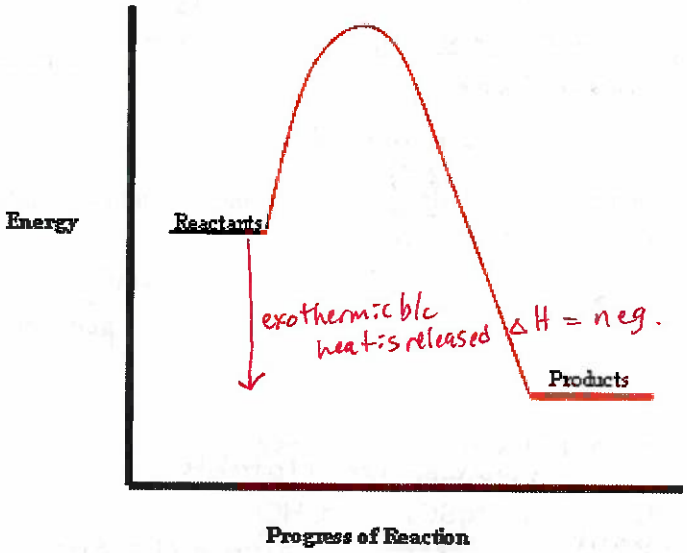
soluble so spectator ions in net ionic eq

a. Only Ba^{2+} b. only SO_4^{-2} c. only Na^+ d. only Cl^{-1} (e) both Na^+ and Cl^-

$Ba^{2+} + 2Cl^- + 2Na^+ + SO_4^{2-} \rightarrow BaSO_4 + 2Na^+ + 2Cl^-$

Key

16. Consider the following energy profile. Of the statements listed, which is correct for this diagram?



a. The reaction is endothermic. ✗
b. The ΔH for the reaction is positive. ✗
c. Energy is transferred to the surroundings. ✓
d. The temperature of the system would decrease.
e. Energy would be written as a reactant. ✗ ↳ pdt.

17. From the given thermochemical data, determine ΔH° for the following reaction.

$$2\,(CH_3CH_2)_3B\,(l) + 21\,O_2\,(g) \rightarrow B_2O_3\,(s) + 12\,CO_2\,(g) + 15\,H_2O\,(l)$$

O_2: $\Delta H_f = 0$ b/c element in std. state

Substance	$\Delta_f H°$ (kJ/mol)
$(CH_3CH_2)_3B(l)$	-194.6
$B_2O_3(s)$	-1273.5
$CO_2(g)$	-393.5
$H_2O(l)$	-285.8

a. 10671.7 kJ/mol
b. 9893.3 kJ/mole
c. 2147.4 kJ/mole
d. 110671.7 kJ/mol
e. -9893.3 kJ/mol
f. -2147.4 kJ/mol

$$\Delta H°_{rxn} = \Sigma n H_f°(pdts) - \Sigma m H_f°(reactants)$$

$$\Delta H°_{rxn} = \left[(1 \times H_f°_{B_2O_3}) + (12 \times H_f°_{CO_2}) + (15 \times H_f°_{H_2O})\right] - \left[2 \times H_f°_{(CH_3CH_2)_3B}\right]$$

$$= \left[\left(1\,mol \times \frac{-1273.5\,kJ}{mol}\right) + \left(12\,mol \times \frac{-393.5\,kJ}{mol}\right) + (15\,mol \times -285.8)\right] - \left[2\,mol \times \frac{-194.6\,kJ}{mol}\right]$$

$$\Delta H°_{rxn} = \left[(-1273.5\,kJ) + (-4722\,kJ) + (-4287\,kJ)\right] + 389.2\,kJ$$

$$= -10{,}282.5 - 389.2\,kJ$$

$$\Delta H°_{rxn} = -9893.3\,kJ$$

Key

18. The Boston Bruins radio broadcast on WBZ (1030 kHz). What is the wavelength of these **radio** waves?

$1030 \times 10^3 / s$ $\quad c = \lambda\nu$ $\quad \lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8 \, m}{(1030 \times 10^3 / s)}$ $\quad \lambda = 291.1 \, m$ $\quad \lambda = 291 \, m$

f. 3.44×10^{-3} m b. 2.91×10^{-5} m (c) 291 m d. 3.44×10^{-7} m
e. none of the above

19. The orientation of an atomic orbital is given by _____.
a. n, the principal quantum number → E & size
b. l, the angular momentum quantum number – shape
(c) m_l, the magnetic quantum number – orientation
d. m_s, the spin quantum number – up or down of $e^\ominus$ spin ($+\frac{1}{2}$ or $-\frac{1}{2}$)

20. Which of species has the following ground state electron configuration?
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$ = 28 $e^\ominus$s
↳ 4s has no $e^\ominus$s so would have $2e^\ominus$ removed to be a cation

b. Ni (28 $e^\ominus$) b. Ni^{2+} (26 $e^\ominus$s) c. Zn (30 $e^\ominus$s) (d) Zn^{2+} (28 $e^\ominus$s) e. The configuration is invalid.

21. Which of the following compounds has the largest lattice enthalpy?

$E_{lattice} \approx K\frac{Q_1 Q_2}{d}$ ← larger charge; ← smaller radius

a. NaCl (+1 −1) b. K_2O (+1 −2) c. NaF (+1 −1) d. KCl (+1 −1) (e.) CaO (+2 −2) ← largest charge

22. Identify the element in Period 2 which has the following successive ionization energies, in kJ/mol.

$IE_1 = 1314$ $IE_2 = 3389$ $IE_3 = 5298$ $IE_4 = 7471$
$IE_5 = 10992$ $IE_6 = 13329$ ← biggest jump ∴ must be removing from Noble gas configuration (7th $e^\ominus$ removed) $IE_7 = 71345$ $IE_8 = 84087$
∴ 6 valence $e^\ominus$s

b. Li b. B (c) O d. Ne e. None of these choices.

23. The measure of the attraction that an atom has for the electrons in a chemical bond is called
a. Electron affinity – E released when atom gains an $e^\ominus$
b. Ionization energy – E required to remove $e^\ominus$ from atom or ion
(c) Electronegativity
d. Hybridization – relates to # $e^\ominus$ domains around a central atom
e. London Forces – intermolecular electrostatic attraction btwn two molecules

24. Which set of quantum numbers describes an electron in a d orbital at the 5th energy level?

s p d f
0 1 2 3
$l = 2$ $n = 5$

_ _ _ _ _
$M_l = +2\ +1\ 0\ -1\ -2$

a. n = 5 ~~l = 4~~ $m_l = 4$ $m_s = \frac{1}{2}$
b. ~~n = 1~~ l = 5 $m_l = 3$ $m_s = \frac{1}{2}$
c. n = 5 l = 2 ~~$m_l = 5$~~ $m_s = \frac{1}{2}$
(d) n = 5 l = 2 $m_l = 0$ $m_s = \frac{1}{2}$

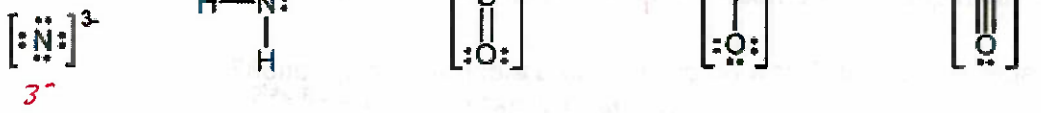
Key

25. An atom of Fe has two 4s electrons and six 3d electrons. How many unpaired electrons would there be in the Fe^{+3} ion?

a. 1 b. 2 c. 3 d. 4 e. 5

26. In which of the following does the nitrogen atom have a formal charge of -1?

a. b. c. d. e.



27. A bonding molecular orbital

a. is lower in energy than the atomic orbitals from which it was formed.
b. may contain antibonding electrons.
c. is designated with an asterisk.
d. has a lack of electron density between the adjacent nuclei.
e. can contain only one electron.

28. How many unpaired electrons in the F_2^{2+} ion based on molecular orbital theory? The order of the molecular orbitals are $(\sigma_{2s})(\sigma^*_{2s})(\sigma_{2p})(\pi_{2p})(\pi^*_{2p})(\sigma^*_{2p})$.

a. 0 b. 1 c. 2 d. 3 e. 4

29. How many hybrid orbitals are produced from mixing one *s* atomic orbital and two *p* atomic orbitals?

a. 3 sp^3 orbitals
b. 3 sp^2 orbitals
c. 3 sp orbitals
d. 2 sp orbitals
e. 2 sp^2 orbitals